IV.H.4 EVermont Hydrogen Electrolyzer Project*

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Subcontractors:
Northern Power Systems, Waitsfield, VT 05673
Proton Energy Systems, Inc., Wallingford, CT 06492

Start Date: 10/1/04
Projected End Date: 11/15/06

**Congressionally directed project*

Objectives

- Develop advanced proton exchange membrane (PEM) electrolysis fueling station technology.
- Build and test a validation system in Vermont that utilizes renewable electricity and is capable of providing hydrogen fuel to vehicles.
- Procure a hydrogen fueled vehicle for testing and validation of the station.

Technical Barriers

This project addresses the following technical barriers from the Hydrogen Production section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- G. Capital Cost
- H. System Efficiency
- I. Grid Electricity Emissions
- K. Electricity Costs

Contribution to Achievement of DOE Hydrogen Production Milestones

This project will contribute to achievement of the following DOE Hydrogen Production milestones from the Hydrogen Production section (3.1) of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- *Milestone 7: Verify feasibility of achieving $2.85/gge (delivered) from electrolysis*
  Several activities under the EVermont project will support this milestone. An advanced lower cost, more highly efficient PEM electrolysis cell stack will be field tested and evaluated. An advanced, low-cost power supply will be field tested and evaluated. Time-of-day/time-of-year electricity pricing will be monitored to determine favorable periods for which low-cost hydrogen can be produced.

Approach

- Bench test the advanced PEM cell stack in-house, and then install and operate the advanced cell stack in the electrolysis system at the fueling station in Vermont
- Bench test the advanced power supply in-house, and then install and operate the advanced power supply in the electrolysis system at the fueling station in Vermont
- Devise a computer algorithm to predict system efficiency and time-of-day electricity pricing to determine the most favorable periods for which to produce low-cost hydrogen
- Install and monitor the operation of the fueling station remotely and analyze the data for efficiency and operating cost
- Procure a hydrogen vehicle for use at the fueling station site in Burlington, VT

Accomplishments

- Successfully tested the full-scale advanced PEM electrolysis cell stack in-house and observed 5-10% efficiency improvement
- Successfully tested full scale advanced (low-cost) power supply in-house
- Completed first version of computer algorithm for determining price of hydrogen production considering system efficiency and time-of-day electricity pricing
- Completed fueling station site plan/layout for the installation location in Burlington, VT
- Procured stock Toyota Prius and signed contract with Quantum to convert the stock Prius to operate on hydrogen fuel

Future Directions

- Complete station site permitting and preparation
- Assemble and test entire fueling station in-house
- Deliver fueling station equipment to site and install and operate the equipment at the site
- Deliver stock Prius to Quantum so that Quantum can convert the vehicle to operate on hydrogen fuel and ship the vehicle back to Vermont.

Introduction

EVermont was formed in 1993 as a public-private partnership of entities interested in documenting and advancing the performance of advanced technology vehicles that are sustainable and less burdensome on the environment, especially in areas of cold climates, hilly terrain and with rural settlement patterns. EVermont has teamed with Northern Power Systems and Proton Energy Systems to carry out this DOE project to utilize renewable electricity to produce hydrogen transportation fuel. Under this project, advanced PEM electrolysis technology will be implemented at a fueling station site in Burlington, VT. This fueling station will serve as a testbed for the advanced technology and to demonstrate a renewable hydrogen fueling pathway for transportation applications.

Current commercial PEM electrolyzers are used in industrial applications today. The life-cycle cost of those systems needs to be improved in order to

gain acceptance into future hydrogen vehicle fueling systems. In this project, focus is being placed upon advancing the state-of-the-art of the cell stack and the power supply. In addition, an effective method for allowing operation in the extreme cold climate of Vermont will be devised and implemented. A hydrogen-fueled vehicle will be procured and operated as part of this project.

Approach

The approach encompasses research and development aspects for electrolysis-based hydrogen fueling systems and fueling system demonstration.

- Test an advanced PEM electrolysis cell stack and advanced power supplies, and then incorporat them into the fueling station.
- Devise and implement a design to allow for outdoor installation of the PEM electrolyzer in extreme cold weather will be.
- Complete in-house testing of the entire fueling station , followed by final siting and commissioning in Burlington, VT.
- Monitor performance of individual subsystems (cell stacks, power supplies) as well as performance of the overall system, including the usage of renewable electricity.
- Procure and operate a hydrogen-fueled vehicle

Results

- The advanced cell stack was successfully tested in-house and is ready for installation in the fueling system.
- The advanced power supplies have undergone several months of successful testing and these power supplies will be available for operation in the fueling system by August 2005.
- The cold-weather heating package was successfully tested in-house.
- Preparations for in-house testing of the entire system have begun. The balance of plant fueling system components (compression, storage, dispensing) have been procured and the equipment layout for the in-house test site has been completed (testing to commence in August 2005).
- Site layout and permitting procedures for final installation in Vermont have been initiated.
- A computer algorithm for predicting system efficiency and price of hydrogen was devised, taking into account time-of-day and time-of-year electricity pricing.
- A Toyota Prius was procured and a purchase order was executed to Quantum to convert the Prius to use hydrogen fuel. This vehicle will utilize the hydrogen fueling station to be installed under this project

Conclusions

Technology development of the advanced PEM electrolysis cell stack and power supplies has progressed successfully, as has the planning for station implementation. Overall to date, the project milestones have been met within budget and schedule. Critical items moving forward include final site preparation and permitting.